DATA EVALUATION RECORD

PC Code 128965 **Etofenprox** Nonguideline
DP Barcode 407817

Reference: IR4 Minor Use Submission in Support of PP No. 1E7925: Tolerance Requests for Etofenprox in All Food and Feed Commodities. Etofenprox (Zenivex E20) Mosquitocide ULV – Ground vs. Aerial Applications 191 pp.

Test material: None

Common name: etofenprox
Chemical name:
IUPAC: 2-(4-ethoxyphenyl)-2-methylpropyl 3-phenoxybenzyl ether
CAS No: 80844-07-1
SMILES string: c1cc(OCC)ccc1C(C)(C)COCc2cc(Oc3ccccc3)ccc2

Study classification: **Supplemental**

Primary Reviewer: Chuck Peck, EPA Reviewer — 11 MAR 2013 (Date)

Secondary Reviewer: Jim Carleton, Ph.D., EPA Reviewer — 3/11/2013 (Date)

This review summarizes individual ground ultralow volume (ULV) spray drift information, provided as references in IR4 submission in support of PP No. 1E7925, regarding the claim that drift from ground ULV applications can be estimated using data from aerial ULV application.

Summary of Results

In the above referenced submission, IR4 submitted eight published articles documenting studies on droplet deposition following ground ULV applications of pesticides. The literature was provided to support IR4's contention that aerial drift data can be extrapolated to represent ground drift for ULV applications. Such an extrapolation would allow for deposited residues on crops, measured following aerial ULV application, to also represent deposited residues following ground ULV applications for risk calculation purposes.

Table 1 below presents a summary of the peak deposition rates reported in the 8 published studies submitted by IR4. Peak deposition rates in these articles range from 2.92 to 14,389 ng/cm^2, or 2 to 33% of the amount applied. Most of the studies indicated a decrease in deposition as the distance from the source increased. It should be noted that the studies used dosimeters of widely-varying construction and application (*e.g.*, filter paper on the ground,

aluminum paper on mannequins, sod, etc.) to measure deposition, and conducted the studies in a variety of application surroundings (mosquito impoundment, communities, open fields), so direct comparison of measured deposition rates between studies may not be appropriate. Nevertheless, consensus of the studies indicates that ground deposition of ULV-applied pesticides is similar to that from aerially-applied ULV pesticides (*i.e.*, deposition rates of 0-33% of the applied pesticide).

Table 1. Summary of peak deposition rates reported in literature studies

Reference / Number	Material	Peak deposition (ng/cm^2)	Peak deposition (% applied)[1]	Distance from application source to peak deposition (m)	Wind speed (mph)
Tucker *et al* 1987	Fenthion	2.92	2	8	Not reported
	Malathion	85.8	15	8	Not reported
	Naled	57.3	20	8	Not reported
Moore *et al* 1993	Malathion	84.1	14	30.4	0.9 – 3.4
Tietze *et al* 1994	Malathion	50	9	5	2.1 – 4.0
Knepper *et al* 1996	Malathion	9,222	NA	7.6	1
	Permethrin	14,389	NA	7.6	1
Tietze *et al* 1996	Malathion	473	NA	Unknown	0 – 2.5
Schleier and Peterson 2010	Naled	74	33	50	1.5
	Permethrin	4.6	5.9	25	4.3
Pierce *et al* 2005	Permethrin	5.1	10	Unknown	6 - 12
Preftakes *et al* 2011	Permethrin	8	10	25-50 m	4.8

1. NA – insufficient information to assess.

Review of References

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1. Tucker, J., Thompson, C., Wang, T., and Lenahan, R. 1987. *Toxicity of organophosphorus insecticides to estuarine copepods and young fish after field applications*. J Florida Anti-Mosquito Association 58:1-6

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition resulting from single-pass application of different pesticides, and only measured deposition at a single distance from the line of application. It is unclear whether the analytical method used to evaluate concentrations in water was the same as the method used to analyze concentrations deposited on filter paper. Information on the release height of the spray was not provided.

Study Methods:

Nine tests were conducted examining the deposition of three pesticides (fenthion, malathion, and naled) using aerial and ground ULV applications. Three of the field tests were conducted using ground ULV application of all three pesticides via truck. The study area was in St. Lucie mosquito impoundment number 23, located on the west side of North Hutchinson Island, in northern St. Lucie County, Florida. Two platforms (one for testing and one for controls) for samplers were located in a perimeter ditch adjacent to the upland fringe of the impoundment, approximately 8 meters from the dike on which trucks were driven while spraying. The fringe consisted of a revegetating black mangrove-saltwort-glasswort marsh. The ditch opened into and had continuous water exchange with the Indian River. The platforms were 3,200 meters apart and equidistant from the inlet. Spraying was conducted at the downwind test platform, to minimize the chance of drift to the control platform.

Fenthion (Baytex liquid concentrate, 93% fenthion) was sprayed at a rate of 0.013 lbs a.i./A in October. Malathion (Cythion liquid concentrate, 91% malathion) was sprayed at a rate of 0.05 lbs a.i./A in October. Naled (Dibrom liquid concentrate, 85% naled) was applied at a rate of 0.025 lbs a.i./A in December.

Two or more no. 44 Whatman filter papers, 24 centimeters in diameter, were placed on the platforms to determine the amount of insecticide deposited. After the spray had drifted past (12-24 minutes after spraying), the filter papers were removed and extracted. Samples of the ditch water were also collected at the test and control platforms. At the test platform, one pair of water samples was collected prior to spraying and 12 pairs were collected up to 48 hours after spraying (duration between sampling not specified). At the control platform, one pair of samples was collected prior to spraying and two pairs were collected after spraying (duration between sampling not specified). One-liter amber glass bottles were used to collect two simultaneous 900 mL samples 2.5 cm below the water surface.

It is unclear from the article whether filter papers were extracted using the same method as water samples. For the water samples, each sample was acidified with 0.15 mL concentrated hydrochloric acid, reducing the pH to 6.0. The sample was immediately extracted with 50 mL of methylene chloride (fenthion) or petroleum ether (malathion and naled) with three one-minute shakes. Samples were placed on ice and taken to the laboratory for two more extractions with hexane. The extracts were passed through a Na_2SO_4 column and then placed in an evaporator with a 5 mL ampule for concentration to 0.5 mL with a gentle stream of nitrogen gas. Concentrated extracts were analyzed with a Hewlett-Packard 5730A gas chromatograph (column specifications not provided) equipped with a nitrogen-phosphorus detector. To determine deposition on filter paper, a calibration curve was constructed by analyzing known amounts of working standard solutions spiked to filter papers. Minimum detectable concentrations in water were 0.01 µg/L for fenthion and 0.05 µg/L for malathion and naled. Detection limits for the filter paper samples were not provided.

Summary of Reported Results:

Drop size distributions for the ground ULV applications were not determined. Wind speed and direction data were not provided in the article. However, a review of the Baytex (fenthion) label indicates for ULV nonthermal aerosol applications that the median droplet size ranges from 5-20 microns with a mass median diameter no to exceed 15 microns. For Cythion (malathion), the label indicates that, for ULV applications, the spray particles should have a mass median diameter of 30 to 100 microns. For the Dibrom (naled) label, the label indicates that the mass median diameter of the droplets should not exceed 15 microns, and that no droplets should be larger than 50 microns for non-thermal ground ULV applications.

Average deposition rates (estimated as the mean of two samples) for fenthion, malathion, and naled were 2.92, 79.3, and 57.3 ng/cm^2, respectively, 12 minutes after spraying, and 2.12, 85.8, and 53.8 ng/cm^2, respectively, 24 minutes after spraying. Maximum deposition percentages for fenthion, malathion, and naled were 2%, 15%, and 20% of the applied, respectively. Efficacy tests conducted in conjunction with the deposition tests indicated that the amount of insecticide declined rapidly with distance from the truck.

The maximum percent of aerially-applied naled reaching the ground (67%) was greater than that resulting from application by truck (20%). Percentages of fenthion and malathion deposited were similar between air and ground applications.

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2. Moore, J.C., Dukes, J.C., Clark, J.R., Malone, J., Hallmon, C.F., Hester, P.G. 1993. *Downwind drift and deposition of malathion on human targets from ground ultralow volume mosquito sprays*. J Am Mosq Control Assoc 9:138-142

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition from a single-pass application of malathion. Droplet data indicate that the volume median diameter (VMD) of the droplets was below 17 microns. Only a summary of the droplet size data was provided in the report, and the droplet spectrum was evaluated at 7.6 meters downwind. Information on the release height of the spray was not provided.

Study Methods:

Five truck-mounted ULV applications of malathion were monitored for drift and deposition in Florida in April, May, August, and October, 1989. Malathion (Cythion, 91% a.i.) was sprayed at a rate of 58.5 g a.i./ha (0.052 lbs a.i./A) using a truck-mounted ULV aerosol generator, operated at 6 psi and a flowrate of 4.3 fluid ounces per minute. Applications were made between 17:15 and 19:15 h. The vehicle speed was 10 mph. Wind speeds were between 1.5 and 5.5 km/hr (0.9 and 3.4 mph). Two teflon-coated slides in a rotating impinger were placed adjacent to the individual located 7.6 m downwind. Droplet VMD deposited on the teflon-coated slides was measured using a compound microscope.

Deposition was monitored on samplers attached to body surfaces of three human subjects. Two subjects were placed in standing, stationary positions 7.6 and 15.2 m downwind and facing the path of the spray vehicle. The third subject jogged in the same direction as the path of, and downwind (1.5 m) of the spray vehicle. Body surface samplers consisted of pieces of sterile surgical gauze (280 cm^2 each) placed on left and right portions of the torso, arms, and legs. A 181 cm^2 area was also sampled from cotton dust masks worn by the test subjects. Stationary human subjects remained standing for approximately 5 minutes while the spray cloud passed through the test area.

Malathion was also collected on precleaned filter paper (24 cm^2 diameter, Whatman #3 or #4 filter paper) that had been placed on styrofoam sheets at sampling distances of 15.2, 30.4, and 91.2 meters downwind of the spray path. Filter papers were left in place for 10 minutes after application before they were collected.

Filter papers, gauze patches, and face mask samples were placed in individual 150 mL Qorpak bottles with a minimum of 100 mL of nanograde petroleum ether. Each bottle was capped, labeled, and placed on ice in a cooler and shipped to the U.S. EPA Gulf Breeze Environmental Research Laboratory in Florida. Samples were kept cool and in the dark until analyses were performed. Analyses were performed within 24 hours of collection.

All sample extracts (petroleum ether from the Qorpak bottles) were initially analyzed without preparation to determine if either concentration or dilution were necessary. Sample extracts were concentrated to a minimum sample size of 5 mL. Analyses were conducted using a Hewlett Packard model 5985 gas chromatograph equipped with dual nitrogen phosphorus detectors. The extraction efficiency for spiked gauze, with levels ranging from 50 to 1000 µg per 280 cm^2, was 97.6 ± 15% (n=26). The extraction efficiency for spiked filter paper, with levels ranging from 100 to 500 µg per 452 cm^2, was 81.8 ± 22% (number of samples not reported). Field recovery efficiencies for gauze and filter paper were 89.9 ± 11% (n=9) and 93.1 ± 17% (n=8), respectively.

Summary of Reported Results:

The measured VMD ranged from 13.2 to 16.2 microns at 7.6 meters downwind.

Average deposition rates for the human subjects are provided in **Table 2**. The mean deposition rates for the jogger torso and arm samples exceed the theoretical application rate (0.052 lbs a.i./A, or 0.58 µg/cm^2), possibly because of the proximity to spray. The mean malathion deposition rates for the stationary subject at 7.6 m ranged from approximately 5% of the applied malathion (head samples) to 46-56% of the applied malathion (torso and arm samples). The mean malathion deposition rates for the stationary subject at 15.2 m ranged from approximately 7% of the applied malathion (head samples) to 39-44% of the applied malathion (torso and arm samples).

Table 2. Average malathion (µg/cm^2) ± SD deposited on gauze surfaces placed on various body areas for human subjects during 5 ground ULV mosquito sprays

Distance from source		Torso	Arms	Legs	Head
1.5 m jogger	Mean	1.19 ± 1.38	1.50 ± 1.67	0.39 ± 0.45	0.20 ± 0.21
	n	20	20	20	5
7.6 m stationary	Mean	0.27 ± 0.33	0.33 ± 0.34	0.22 ± 0.34	0.03 ± 0.01
	n	20	20	20	5
15.2 m stationary	Mean	0.23 ± 0.10	0.26 ± 0.08	0.14 ± 0.04	0.14 ± 0.02
	n	20	20	20	5

Results of the filter paper deposition for four of the trials (the four trials are believed to be trials 2-5, based on the Discussion section of the paper, although the tabular results indicate that they are trials 1-4) are provided in **Table 3**. Maximum deposition rates for distances of 15.2, 30.4, and 91.2 m were 12%, 14%, and 4.2% of the applied malathion, respectively. The deposition rates for the filter paper at 15.2 m are much lower (1-2 orders of magnitude) than those developed for the stationary subject at 15.2 m, most likely because the filter paper was placed flat on the ground, representing a horizontal sampling of the drift, while the stationary subject represented more of a vertical sampling of the drift. However, deposition on the stationary subject may be more reflective of upright vegetation, as a vertical crop canopy would likely intercept more pesticide than flat ground.

Table 3. Average malathion deposited on filter paper placed at ground level during 4 ground ULV mosquito sprays

Spray	Replicate	Malathion (ug)			Malathion[1] (ng/cm^2)			Malathion[2] (% applied)		
		Distance (m)			Distance (m)			Distance (m)		
		15.2	30.4	91.2	15.2	30.4	91.2	15.2	30.4	91.2
1	1	lost	7.3	5.7	lost	16.15	12.61	lost	2.76	2.15
	2	4.4	7.2	4.6	9.73	15.93	10.18	1.66	2.72	1.74
	3	4.7	9.8	4.8	10.40	21.68	10.62	1.78	3.70	1.81
2	1	5.7	3.4	4.5	12.61	7.52	9.96	2.15	1.28	1.70
	2	4.4	6.8	3.8	9.73	15.04	8.41	1.66	2.57	1.44
	3	1.9	3.7	3.7	4.20	8.19	8.19	0.72	1.40	1.40
3	1	8.7	6.5	11	19.25	14.38	24.34	3.29	2.46	4.16
	2	8	5.3	11	17.70	11.73	24.34	3.02	2.00	4.16
	3	7.8	9.4	11	17.26	20.80	24.34	2.95	3.55	4.16
4	1	32	38	3.3	70.80	84.07	7.30	12.09	14.36	1.25
	2	15	33	2.4	33.19	73.01	5.31	5.67	12.47	0.91
	3	28	31	2.3	61.95	68.58	5.09	10.58	11.71	0.87

1. The surface area of the filter paper was 452 cm^2.
2. The application rate was 58.5 g/ha or 0.052 lbs/A.

3. **Tietze, N.S., Hester, P.G., and Shaffer, K.R.. 1994. *Mass recovery of malathion in simulated open field mosquito adulticide tests*. Archives of Environmental Contamination and Toxicology 26:473-477**

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition from a single-pass application of malathion. Individual replicate deposition data were not provided. Droplet data indicate the 99% of the droplets were below 24 microns. Only a summary of the droplet size data was provided in the report. Information on the release height of the spray was not provided.

Study Methods:

Six field tests were conducted to assess deposition rates of malathion at different distances from the path of application. Trials were conducted during dusk hours (times not specified) on various dates between May and August of 1993 at a sod farm in Southport, Florida. Malathion (Cythion, 95% malathion) was applied via a truck-mounted ULV cold aerosol generator (Leco 1600) at a blower pressure delivering 0.421 kg/cm^2. Malathion was delivered to the Leco at a rate of 4.3 fluid ounces/minute. The truck was driven at a speed of 10 mph for a distance of about 200 meters before and 200 meters beyond the sampling sites. Meteorological data (wind speed, air temperature, humidity) were also measured during each test, at ground level and at a height of 8.2 meters above the ground. Sampling sites were aligned with the wind direction, while the path of the vehicle varied from 45 to 90 degrees relative to that of the wind. Sampling distances were positioned 5, 25, 100, and 500 meters from the spray head along the path of the wind direction.

To verify that the spray droplets were within limits specified on the label, swing slides were taken on each treatment day as prescribed by the label. A rotating impinger fitted with Teflon-coated slides was placed adjacent to the central filter paper at each site. Impingers were fitted with threaded stakes to secure them to the ground. Blades rotated about 10 cm above the ground. The mass median diameter (MMD) of the droplets and relative abundance were assessed from the impinger slides about 12 to 20 hours after application. The MMD was determined for each distance by visual assessment using a compound microscope at 400x magnification and a correction factor of 0.69 (a spread factor for Teflon-coated slides that allows the measurements to be converted to microns, as specified on the Cythion label). The relative abundance of droplets was assessed by enumerating droplets within a 40 mm^2 area using a compound microscope at 100x magnification. The abundance of droplets was determined along the edge and the center of the slide.

Malathion deposition was collected using three filter papers (Whatman #3, 452 cm^2) at each distance, spaced 3 to 4 meters apart and aligned parallel to the course of the truck. Filter paper was washed in solvent (of unspecified composition) prior to testing and pinned to Styrofoam pads with aluminum foil separating the paper from the Styrofoam. Samples were collected about 20 minutes post application. Filter papers were folded and placed into pre-cleaned 150-mL Qorpak bottles and immersed in 100 mL American Chemical Society (ACS) grade acetone.

During each trial, filter paper was spiked with 22 ng/cm^2 of malathion to determine percent recovery. Blank samples (bottles filled with acetone) were also used for quality control purposes. Bottles were stored overnight at 4°C.

Filter paper samples were analyzed about 12 to 20 hours after application. Samples were analyzed using a Varian 3400 gas chromatograph equipped with an Inboard Data Handling option, split/splitless injector, DB-5 capillary column connected to a thermionic sensitive detector. The carrier gas was helium at 25 mL/min and detector bases were hydrogen and air at 4.5 and 175 mL/min, respectively. The temperature was set to 230°C for the injector. The column was held at 80°C for 1 minute, then increased at 20°C/min to 200°C and held for 6 minutes. The detector temperature was 300°C. The mass of malathion recovered was determined by factoring out the volume of rinse acetone. Calibration standards (10, 25, and 50 ppb malathion) and an acetone blank were run during each test.

Summary of Reported Results:

The reviewer was able to confirm study authors' estimated application rate of 577 ng/cm^2.

The average MMD for the five tests was 12.73 ± 0.60 microns. The average size of the largest droplet recovered was 26.6 ± 2.52 microns. Information about the droplet size distribution is provided in **Table 4**.

Table 4. Average drop size distribution for malathion applications

Droplet size (micron)	Average Cumulative Percentage
< 18	86.9 ± 3.31
< 24	98.9 ± 0.52
> 32	0.13 ± 0.13

Percent recovery of malathion from the spiked filter paper ranged from 92 to 98%. No malathion was detected in the acetone blanks.

Of the six field trials, five were considered acceptable by the study authors, with the sixth trial occurring during negative air stability (*i.e.*, the air temperature at 8.2 m above ground was lower than the temperature measured at ground level, resulting in convective updrafts that tend to increase the length of time that droplets remain suspended in the air). The average wind speed for the five acceptable trials was 4.8 ± 1.4 km/hr (3.0 ± 0.9 mph), relative humidity averaged 79.6 ± 8.8%, and the temperature increased with height. The average wind speed for the sixth trial was 2.4 km/hr (1.5 mph) and the average relative humidity was 76%.

For the five acceptable trials, the deposition rate averaged 33.36, 16.75, 15.72, and 2.10 ng/cm^2 at distances of 5, 25, 100, and 500 meters, respectively. Based on these averages, approximately 5.8, 2.9, 2.7, and 0.4% of the applied amount occurred at distances of 5, 25, 100, and 500 meters, respectively. A graphical depiction of the results for the five field trials is provided in **Figure 1**. Based on the whiskers in **Figure 1**, the deposition rates at the 5 meter distance were as high as 50

ng/cm^2, indicating deposition was as high as 9% of the applied. Individual replicate data were not provided in the report. The general conclusion from the report was that deposition decreased with distance from the spray head.

The results of the sixth field trial are depicted in **Figure 2**. Apparently due to the unstable atmospheric conditions, deposition increased with distance. This is consistent with expectations, as during atmospheric instability, ULV aerosols would be expected to remain suspended in the air for longer periods of time, and to therefore travel farther downwind before depositing.

Figure 1. Mass of malathion deposited on filter papers as a function of distance from spray head (n=5)

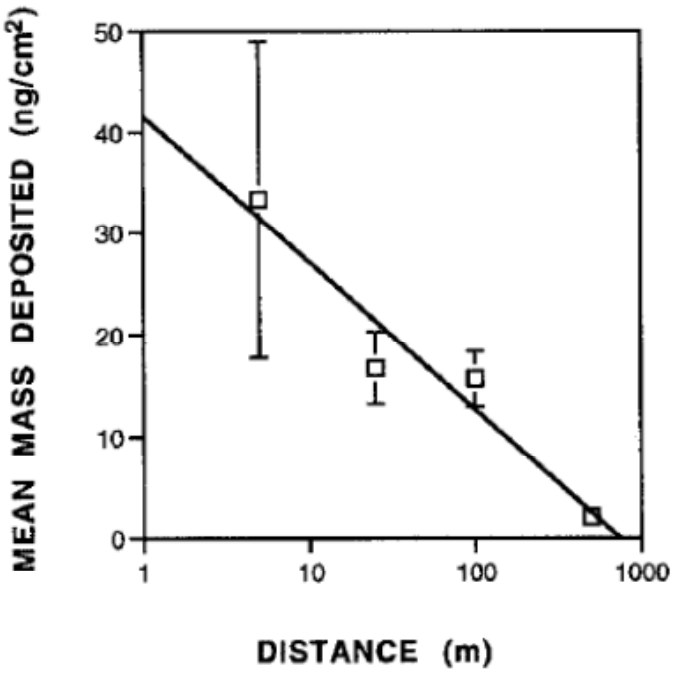
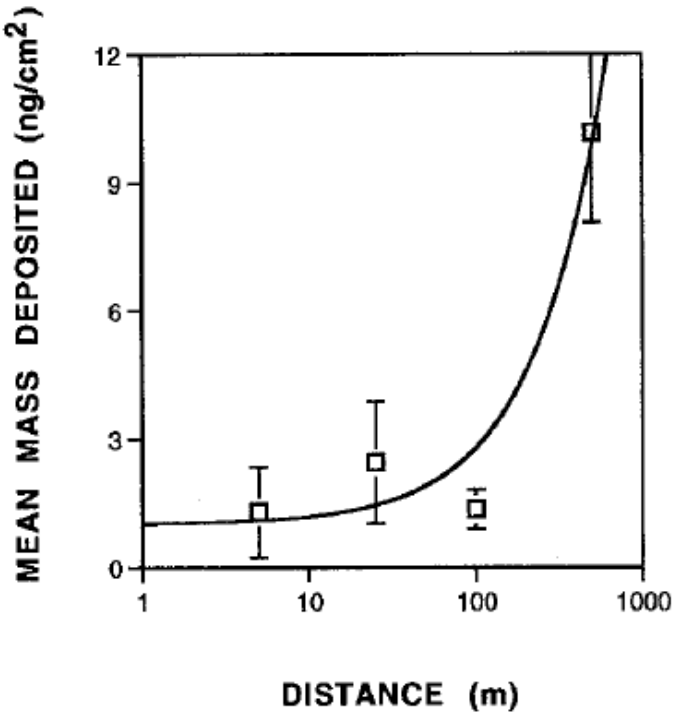


Figure 2. Mass of malathion deposited on filter papers as a function of distance from spray head during field trial with air instability



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4. **Knepper, R.G., Walker, E.D., et al. 1996.** ***Deposition of malathion and permethrin on sod grass after single, ultra-low volume applications in suburban neighborhood in Michigan*****. J Am Mosq Control Assoc 12:45-51**

<u>Reviewer Conclusions</u>:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition from separate, single-pass applications of malathion and permethrin. An application rate could not be determined. Droplet data indicate the MMDs of the droplets were below 30 microns, comparable to requirements for etofenprox ground ULV applications. Information on the release height of the spray was not provided.

<u>Study Methods</u>:

A study was conducted in July 1993, in a residential community in Saginaw County, Michigan, evaluating the deposition of malathion (Cythion ULV, 95% malathion) and permethrin (Biomist 4+12, 4% permethrin). The community consisted of a 30-year old subdivision of single family dwellings (lot sizes not specified), typical of a suburban setting in the Midwest. Blocks of sod grass (0.3 m x 0.6 m, 0.18 m^2), placed in plastic horticulture flats, were used as samplers for pesticide deposition. The flats were watered during the experiment to prevent the grass from drying. The blocks were placed in 2 sets of 4 lines each (backyard and frontyard), parallel and

downwind from the course of the nearby street (Fromm Drive in **Figure 3**), at distances of 7.6, 15.2, 30.4, and 91.4 meters from the edge of the street.

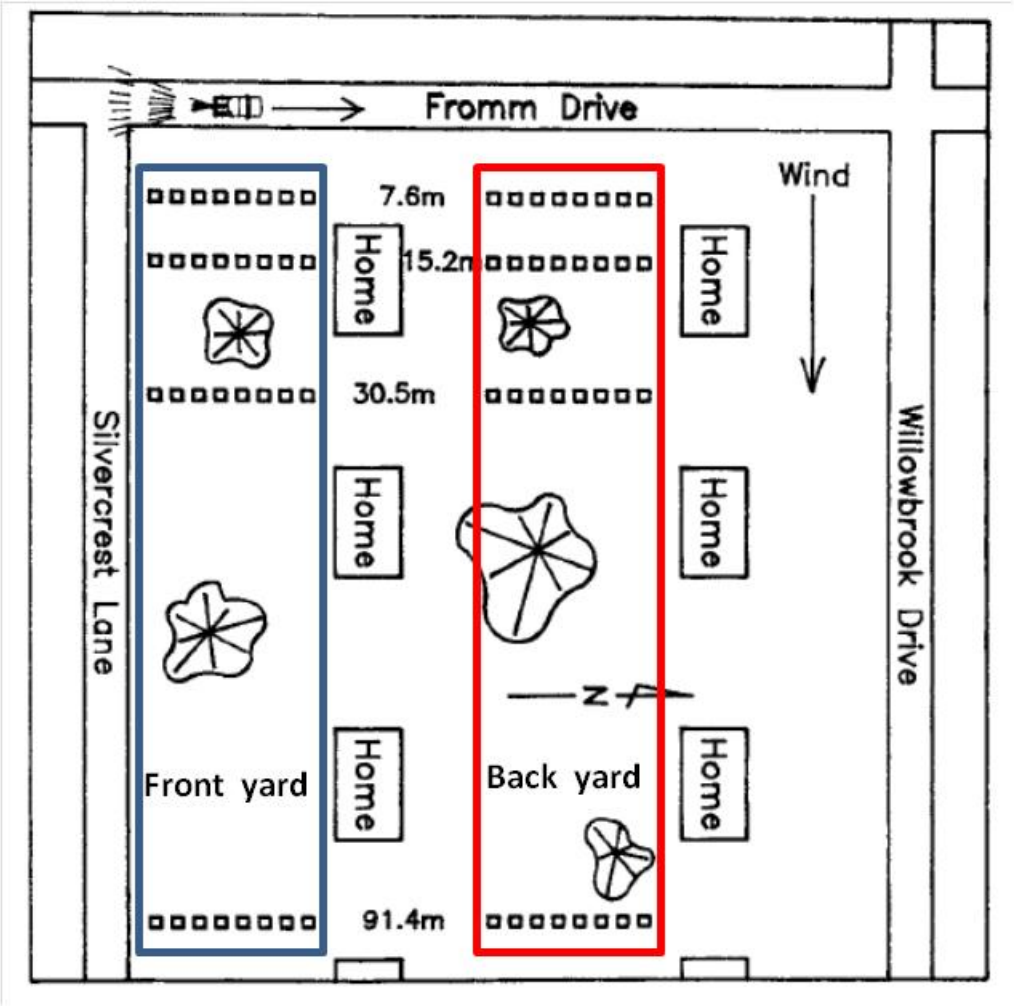
Cythion ULV was applied at a flow rate of 104 mL/min and a truck velocity of 10 mph. Biomist was applied at a flow rate of 148 mL/min and a truck velocity of 10 mph. Applications were made between 2100 and 220 hours using a LECO Model 1600 cold aerosol generator mounted on a one-half-ton pickup truck. Insecticides were delivered by a positive displacement pump digital flow control. The truck drove northerly on Fromm Drive; the duration of the spray events and the amounts of pesticide applied were not provided. Weather data (temperature, relative humidity, wind speed, and wind direction) were collected during the experiment using an on-site weather station (Weather Monitor II).

Prior to application, insecticide droplets were collected from the spray cloud using silicone-coated glass microscope slides and the hand wave method (*i.e.*, holding out a coated slide and waving it perpendicular to the movement of the aerosol). Droplet MMDs were calculated from slide counts. Study authors determined that the droplet sizes were consistent with the requirements stipulated on the product labels. During the experiment, insecticide droplets were collected at downwind distances of 7.6, 15.2, and 30.4 meters from the road, using silicone-coated microscope slides mounted on mechanical slide rotators set equidistantly between the duplicate sets of sod blocks. Rotators spun at a rate of 350 rpm for 15 minutes during and after treatment.

Grass was sampled from the sod blocks by clipping all grass from the top of the sod with shears and placing the material into clean glass jars fitted with aluminum foil seals inside the lids. Jars were placed on wet ice for transport to the laboratory, where they were stored at -20ºC. Shears were rinsed once in acetone, then in water between clippings.

Grass samples were extracted with equal volumes of hexane and acetone, shaken for 5 minutes, and mixed with 5% sodium chloride, and the hexane fraction was drawn off for analysis using gas chromatography using a DB-5 column with electron capture detection. The limits of detection for permethrin and malathion were 0.1 ppm and 0.05 ppm, respectively.

Figure 3. Schematic of sod grass locations



<u>Summary of Reported Results</u>:

Droplets collected on silicone-coated slides mounted on rotators indicated MMDs of 15.7, 16.1, and 8.9 microns at 7.6, 15.2, and 30.4 meters, respectively, for the permethrin application. Droplets collected on silicone-coated slides mounted on rotators indicated MMDs of 10.6, 21.2, and 29.6 microns at 7.6, 15.2, and 30.4 meters, respectively, for the malathion application.

During the applications, the temperature was 18ºC, the relative humidity ranged from 52 to 62%, and the wind was easterly with a velocity of 1.6 km/hr (1 mph).

Sod collected before the applications indicated non-detect levels for malathion and permethrin. Deposition values for the remaining sampling events are provided in **Table 5**. The maximum deposition values occurred in the first 15 minutes post-application, and decreased with time. Deposition values also decreased with distance from the street where the application was made. Maximum deposition values for permethrin and malathion were 14,389 and 9,222 ng/cm^2, respectively, 7.6 meters from the street. Because an application rate could not accurately be determined, the percent of the amount applied could not be determined.

Table 5. Deposition of permethrin and malathion on sod grass blocks

Time after application (hr)	Distance (m)	Location	Mass (mg)		Deposition (ng/cm^2)	
			Permethrin	Malathion	Permethrin	Malathion
0.25	7.6	Frontyard	25.9	16.6	14,389	9,222
		Backyard	23.7	15.7	13,167	8,722
	15.2	Frontyard	10.2	4.3	5,667	2,389
		Backyard	12.1	5.1	6,722	2,833
	30.5	Frontyard	7.2	1.4	4,000	778
		Backyard	3.8	1.6	2,111	889
	91.4	Frontyard	1.3	0.3	722	167
		Backyard	0.9	0.4	500	222
12	7.6	Frontyard	8.1	4.3	4,500	2,389
		Backyard	6.7	3.1	3,722	1,722
	15.2	Frontyard	3.3	0.6	1,833	333
		Backyard	5.6	0.4	3,111	222
	30.5	Frontyard	0.1	0.4	56	222
		Backyard	0.2	0	111	0
	91.4	Frontyard	0.3	0	167	0
		Backyard	0	0.1	0	56
24	7.6	Frontyard	1.5	0.3	833	167
		Backyard	0.2	0.4	111	222
	15.2	Frontyard	0.3	0.3	167	167
		Backyard	1.6	0.1	889	56
	30.5	Frontyard	0	0.2	0	111
		Backyard	0	0	0	0
	91.4	Frontyard	0	0	0	0
		Backyard	0	0	0	0

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5. Tietze, N.S., Hester, P.G., Shaffer, K.R., and Wakefield, F.T. 1996. *Peridomestic deposition of ultra-low volume malathion applied as a mosquito adulticide.* Bulletin of Environmental Contamination and Toxicology. 56:210-218

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition from multiple pass applications of malathion in a residential neighborhood. An application rate could not be determined. Droplet data indicate the MMDs of the droplets were below 30 microns, comparable to requirements for etofenprox ground ULV applications.

Study Methods:

Five ground ULV spray applications were conducted from June to September, 1994, in a residential area of Panama City, FL. Four houses located on the western side of alternating blocks were selected for evaluation (**Figure 4**). The arrangement was selected to base sprays on westerly winds known to occur in the area. The study area was moderately vegetated, with various trees and shrubs. Four sampling sites were established around each house; one in the front yard, one beside the house, one behind the house, and one in the backyard. Sampling sites for the front, side, and behind the house were positioned on the ground at the middle of each facade, approximately 2.4 meters away from the structure. The sampler positioned in the backyard was positioned approximately 2.4 meters away from the fence delineating the property line (**Figure 4**). During each test, the distance from the street curb to the sampling sites was also determined.

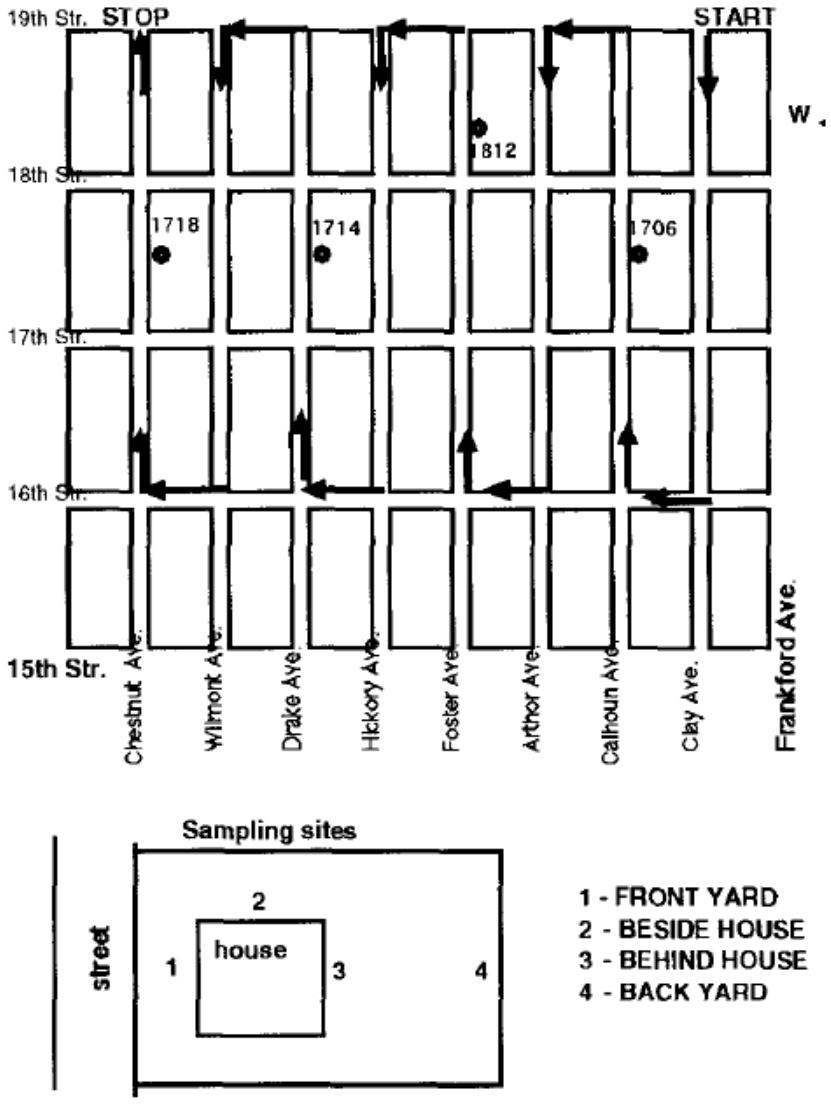
Malathion (Cythion ULV concentrate, 95% a.i.) was applied by the Bay County Mosquito Control District using a Tuthill Corp. blower powered by an 18 horsepower, twin cylinder Briggs and Stratton motor mounted on a pickup truck. The spray head was extended to 2.13 meters above the ground and angled at 45° above the horizontal. An Adapco Monitor and Modular Flow control Pump was used to deliver spray at a constant rate of 127 mL/minute, automatically adjusted for vehicular speed. The Adapco system automatically shut off the sprayer when the vehicle speed was less than 3.2 km/hour (2 mph) and was manually shut off when pedestrians were present. The average speed of the vehicle was between 21.1 and 25.4 km/hour. The Adapco system recorded distance and volume sprayed, average speed traveled, and duration of the spray interval. Applications were initiated between 1900 and 1930 hours.

Prior to each test, label-specified drop size requirements (MMD ≤ 17 microns, no droplets greater than 48 microns) were validated by sampling droplets using the swing slide technique (*i.e.*, swinging the slide through the spray cloud, similar to the hand wave technique) and correction factor of 0.69 (a spread factor for Teflon-coated slides that allows the measurements to be converted to microns, as specified on the Cythion label). To sample the relative abundance of droplets and the MMD, a rotating impinger fitted with Teflon-coated slides was placed adjacent to the filter paper on the side of each house (see next paragraph). The impingers were fitted with threaded stakes to secure them to the ground. Blades rotated (rotation rate not specified) about 10 cm above the ground and were collected at the same time as the filter paper. Droplet abundances were determined at the edge and near the middle of each slide. Droplet size was assessed using the swing slide method.

Deposition was measured using filter paper placed horizontally at ground level. The research paper does not describe type of filter paper, but cites Moore, *et al*, 1993 (Reference 2 above). As such, the filter paper is assumed to be pre-cleaned Whatman #3 or #4 filter paper (diameter of 24 cm), placed on Styrofoam sheets covered with aluminum foil. Approximately 30 to 55 minutes after the application, filter papers were collected, folded and placed into pre-cleaned 150-mL Qorpak bottles and immersed in 100 mL acetone. During each test, a single sample was spiked with 300 ppb malathion to determine percent recovery, and a separate sample was filled with acetone only to serve as a blank sample. Bottles were stored overnight at 4°C.

Study authors cited that the analytical method was the same one described in Tietze, *et al.* 1994 (Reference 3 above). Per that citation, samples were analyzed using a Varian 3400 gas chromatograph equipped with an Inboard Data Handling option, split/splitless injector, and a DB-5 capillary column connected to a thermionic sensitive detector. The carrier gas was helium at 25 mL/min and detector bases were hydrogen and air at 4.5 and 175 mL/min, respectively. The temperature was set to 230°C for the injector. The column was held at 80°C for 1 minute, then increased at 20°C/min to 200°C and held for 6 minutes. The detector temperature was 300°C. The mass of malathion recovered was determined by factoring out the volume of rinse acetone. Calibration standards (10, 25, and 50 ppb malathion) and an acetone blank were run during each test.

Figure 4. Map of study sites. Circles indicate houses selected for use in the study. Arrows denote route of spray truck.



Summary of Reported Results:

Specifics of each spray test are provided in **Table 6**. Wind speed was considered too low to be reliably measured using an anemometer (0 to 4 km/hr, or 0 to 2.5 mph), but study authors reported drift was generally out of the west. Average air temperature was 25.5 ± 2.1°C and average relative humidity was 70.8 ± 4.2%. The average distance for the deposition samplers was 11 ± 0.8 meters (front of house), 19.9 ± 0.7 meters (beside house), 28.6 ± 0.6 meters (behind house), and 42.8 ± 0.3 meters (backyard). Recovery of malathion in spiked samples averaged 90% and malathion was never detected in the blank samples.

Table 6. Panama City, FL, field data and droplet size analysis

Date	Spray distance[1] (km)	Volume sprayed (L)	Avg speed (km/hr)	Spray time (min)	Droplet MMD (um)
14-Jun-94	5.5	3.28	22.0	18	17.1
21-Jun-94	4.7	2.81	21.1	16	15.1
28-Jun-94	5.3	3.19	23.2	17	14.3
30-Aug-94	5.7	3.48	23.9	18	13.3
26-Sep-94	5.5	3.25	25.4	16	17.0

1. Distance traveled by truck during spraying.

Average malathion deposition rates for the front yard, side of house, behind house, and backyard were 88.8 ± 24.9, 56.8 ± 11.7, 62.5 ± 23.4, and 29.9 ± 7.8 ng/cm^2, respectively. The mean mass deposited decreased with distance (**Figure 5**). By site location, deposits were greatest at the house on Foster Avenue (**Figure 6**). This house was closest to the street, with a front yard sampler 6.4 meters from the curb. Study authors attributed the high degree of variability in the deposition rates at this site to its proximity to an intersection, where the driver was forced to slow down prior to turning into oncoming traffic. For this site, the highest recorded deposition rates were 442 ng/cm^2 in the front of the house and 473 ng/cm^2 behind the house. Study authors concluded there was no evidence supporting compounding of spray swaths made on alternating streets.

Study authors discussed the results from this study in comparison to one conducted earlier in an open field (Tietze, *et al.*, 1994, results provided in Reference 3 above). Authors indicated that the channeling of spray around the houses and large tress could result in "concentrating" deposition as seen in this study, resulting in higher deposition than those seen in the open field study. Another potential cause of increased deposition was the problems inherent to applications within a busy residential area where oncoming traffic slowed the spray truck down.

Figure 5. Mass of malathion deposited as a function of distance from the street curb. Bars denote standard error of mean.

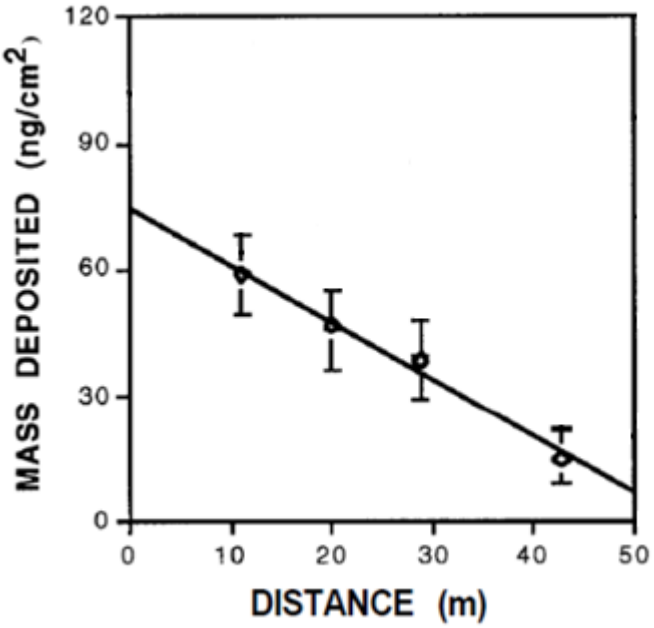


Figure 6. Mean mass of malathion deposited as a function of house/site sampled. Bars denote standard error of the mean.

6. Schleier, J. III and Peterson, R. 2010. *Deposition and air concentrations of permethrin and naled used for adult mosquito management.* Archives of Environmental Contamination and Toxicology. 58(1):105-111

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The study assessed deposition from separate, single-pass applications of permethrin and naled. Assessment of droplet sizes was not conducted, so it is unknown whether the VMD of the droplets was less than 30 microns, a requirement for etofenprox ground ULV applications. Information on the release height of the spray was not provided.

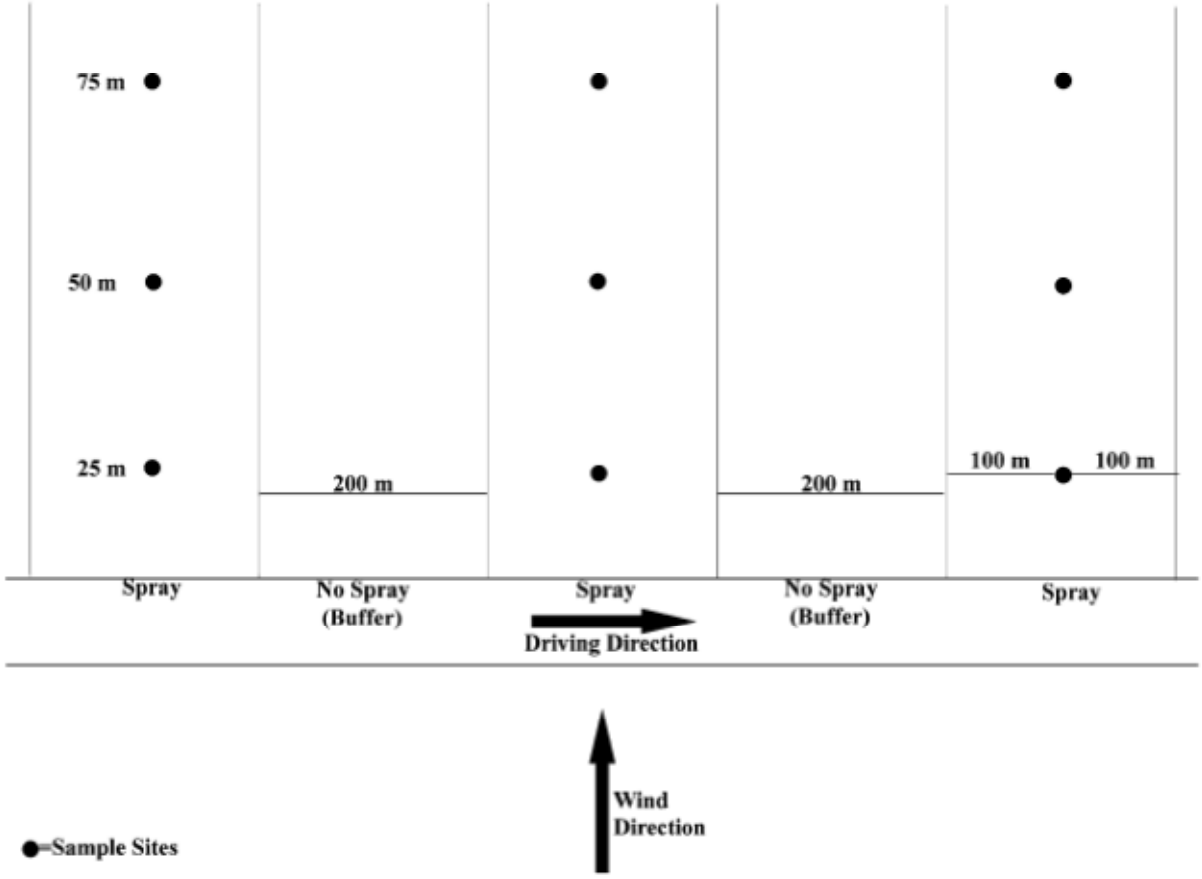
Study Methods:

In 2007, an application of naled and a separate application of permethrin were monitored for deposition at a site near Cascade, Montana. In 2008, an application of naled and a separate application of permethrin were monitored for deposition at a site near Ulm, Montana. The applications took place in open fields with no vegetation taller than 20 centimeters. At each study site, surface samples were collected 25, 50, and 75 meters from the spray source. Three sample replicates were collected, with a 200 meter buffer between sample locations (**Figure 7**).

Insecticides were applied via a truck equipped with a Bison ULV generator. Permethrin (Permanone 10%EC, 10% permethrin) was applied at an application rate of 7.85 g a.i./ha (0.007 lbs a.i./A) and a flowrate of 205 mL/minute on August 12, 2007 (2030 hours) and July 25, 2008 (2015 hours). Naled (Trumpet EC) was applied at an application rate of 22.42 g a.i./ha (0.02 lbs a.i./A) and a flowrate of 44.36 mL/min on August 27, 2007 (2020 hours) and August 12, 2008 (2000 hours). Truck speed was 16.1 km/hr (10 mph) and spraying began and ended 100 meters on each side of the sample collectors. Applications occurred when the prevailing wind was blowing perpendicular to the collection site. Temperature, wind speed, and relative humidity were recorded 1.5 meters above ground level.

Surface residues were collected at ground level and at 1.25 meters above the ground (support mechanism not described) on 10 centimeter by 10 centimeter cotton dosimeters pinned to a piece of cardboard. Cotton dosimeters at 1.25 meters were oriented vertically, *i.e*. perpendicular to the ground. On the pieces of cardboard, cotton dosimeters were separated from each other by 15 centimeters as measured from the edges of the dosimeters. The cardboard was covered with plastic wrap to prevent contact between the cardboard and dosimeter and prevent any soaking through of pesticide into the cardboard. Before each application, dosimeters were placed 25 meters from the spray line at ground level 1.5 hours before spraying and were collected just before applications began (background samples). Untreated areas, located where spraying or drift could not occur, but still subject to the same meteorological conditions as the treated areas, were used for control samples. Spiked cotton dosimeters were dosed with 750 nanograms of technical grade naled or permethrin.

Figure 7. Site layout with wind direction, spray zone, driving direction, and sampling



For permethrin, two dosimeters were pinned on each piece of cardboard at ground level before application and were collected 1 and 12 hours after application. At 25 meters, a third dosimeter was pinned to the cardboard before the application, and was collected 24 hours after the application. Three blank and three spiked dosimeters were placed in an untreated area (not specified whether ground level or elevated) and were collected at 1, 12, and 24 hours after application.

For naled, two dosimeters were pinned on each piece of cardboard at ground level and 1.25 meters above the ground before application. These were collected 1 and 12 hours after application. Two blank and two spiked cotton pads were placed in an untreated area (not specified whether ground level or elevated) and were collected at 1 and 12 hours after application.

Cotton dosimeters were collected with tweezers which were rinsed with acetone between collections. Samples were placed in separate 60-mL I-Chem glass jars with Teflon lids. Jars were placed in a cooler with dry ice for transport form the field to the laboratory. Jars were stored in a freezer at < 4°C until analyzed.

Extraction of samples occurred within 7 days of sampling to avoid losses due to degradation (both pesticides degrade via photolysis). Dosimeters were extracted using 45 mL of high-pressure liquid chromatography-grade hexane. Jars were placed on a shaker table for 2 hours. A 13-mL aliquot was concentrated to 1 mL using a nitrogen evaporator at 30-35°C. Chemical analysis was performed by the Montana State Department of Agriculture's Chemical Analytical Laboratory in Bozeman, Montana. Permethrin analysis was performed on an Agilent 6890 gas chromatograph with an electron capture detector and a Restek RTX-5 column with Intraguard. The temperature program started at 60°C, increased at 25°C/min to 280°C, and was then held at that temperature for 4 minutes. Naled analysis was performed using an Agilent 5973 gas chromatograph-mass spectroscopy detector with a Restek RTX-5 column. The temperature program started at 80°C, increased at 20°C/min to 280°C and was then held at that temperature for 2 minutes. The reported detection limits were 30 ng and 1.5 ng for permethrin and naled, respectively.

Summary of Reported Results:

Weather data from the four applications are summarized in **Table 7**.

Table 7. Meteorological data from permethrin and naled applications

Date	Active ingredient	Wind speed (km/hr)*	Wind direction	Average temperature (°C)	Relative humidity (%)
August 12, 2007	Permethrin	8 (17.7)	From northeast	22	35
August 27, 2007	Naled	2.4 (4.8)	From north	21	33
July 25, 2008	Permethrin	7 (12.9)	From northeast	27	27.5
August 12, 2008	Naled	8 (12.9)	From southwest	24	23

* Numbers in parenthesis represent maximum wind gust reported. For comparison purposes, 10 mph = 16.1 km/hr.

Permethrin was not detected in the control or background dosimeters. Recovery of field and laboratory spikes for permethrin ranged from 94% to 130% in both 2007 and 2008. Study authors indicated that there was no significant difference between concentrations on the ground dosimeters and those at the 1.25 meters above the ground. Therefore, the data were combined for analysis (**Table 8**). Average deposition, percent applied, was estimated by dividing the average deposition by the nominal application rate (0.007 lbs a.i./A).

Table 8. Average deposition rates for permethrin by distance and collection period

Distance (m)	Average deposition ± standard error (ng/cm^2)		Average deposition (% applied)	
	2007	2008	2007	2008
1 hour				
25	2.3 ± 1.2	4.6 ± 0.67	2.93	5.86
50	3.8 ± 1.1	2.3 ± 1	4.84	2.93
75	1.1 ± 0.63	0.94 ± 0.18	1.40	1.20
12 hours				
25	2 ± 1.2	3.7 ± 0.69	2.55	4.72

50	3.1 ± 0.46	1.3 ± 0.39	3.95	1.66
75	0.8 ± 0.5	0.86 ± 0.2	1.02	1.10
24 hours				
25	1.8 ± 1.2	3.9 ± 0.78	2.29	4.97
50	1.3 ± 0.4	0.7 ± 0.32	1.66	0.89
75	0.2 ± 0.1	0.42 ± 0.36	0.25	0.54

Naled also was not detected in control or background dosimeters. Recovery of field and laboratory spikes for naled ranged from 107% to 130% in both 2007 and 2008. There were substantial differences between the dosimeter measurements at ground level and at 1.25 meters above the ground, so the study authors did not combine the data in their analysis. Deposition values are provided in **Table 9**. Average deposition, percent applied, was estimated by dividing the average deposition by the nominal application rate (0.02 lbs a.i./A). Study authors suggested that the increased ground deposition of naled, compared to permethrin, could be the result of the use of a heavier oil in the Trumpet formulation. Study authors also indicated the difference between values obtained in 2007 and 2008 could be the result of different wind patterns and wind speed.

Table 9. Average deposition rates for naled by distance and collection period

Distance (m)	Average deposition ± standard error (ng/cm^2)		Average deposition (% applied)	
	2007	2008	2007	2008
Ground samples				
1 hour				
25	47 ± 0.10	15 ± 2.9	21.0	6.69
50	66 ± 9.6	6.1 ± 2.1	29.4	2.72
75	67 ± 11	ND	29.9	ND
12 hours				
25	51 ± 6.7	20 ± 2.1	22.8	8.92
50	74 ± 7	7.7 ± 2.9	33.0	3.43
75	71 ± 5.8	0.57 ± 0.56	31.7	0.25
Samples 1.25 m above ground				
1 hour				
25	11 ± 2.2	23 ± 5	4.9	10.3
50	6.5 ± 1.5	13 ± 5.4	2.9	5.8
75	4.8 ± 3.7	0.54 ± 0.53	2.1	0.2
12 hours				
25	9.7 ± 1.2	14 ± 1.2	4.3	6.2
50	4.9 ± 0.57	12 ± 3.3	2.2	5.4
75	5.2 ± 3.9	1.6 ± 0.95	2.3	0.7

7. **Pierce, M.C., R.H., Henry, M.S., Blum, T.C., Mueller, E.M. 2005. *Aerial and tidal transport of mosquito control pesticides into the Florida Keys National Marine Sanctuary*. Revista de Biologia Tropical. 53:117-125**

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. Specific application parameters (*e.g.*, vehicle speed, swath width, release height, etc.) were not provided. Assessment of droplet size data was not conducted, so it is uncertain if the VMD of the droplets was less than 30 microns, a requirement for etofenprox ground ULV applications.

Study Methods:

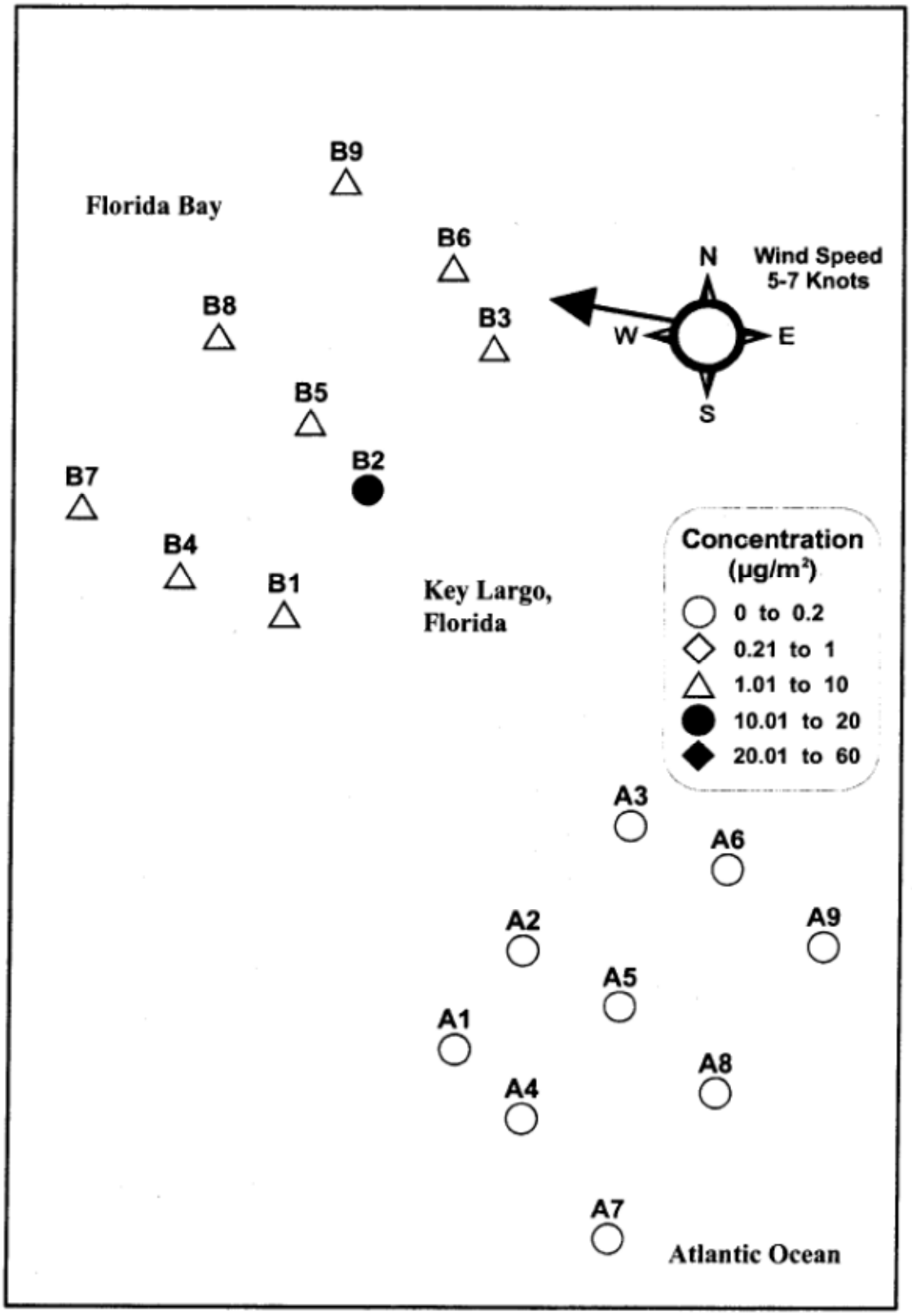
Three trials were undertaken to determine whether mosquito adulticides applied along the Florida Keys could cause adverse effects in the Florida Keys National Marine Sanctuary (FKNMS). The study was conducted in Key Largo, Florida in 1998. Permethrin (Permanone, 4% permethrin) was applied from trucks as ground ULV at a rate of 5.5 fluid ounces per acre.

Prior to each application, a grid of nine sampling sites, covering an area of approximately 1.5 kilometers along shore to 1 kilometer offshore, was established on each of the Florida Bay and Atlantic sides of Key Largo to provide control and drift sampling areas, depending on the direction of the wind (**Figure 8**). Samples collected at each of the eighteen sampling sites included glass fiber filter pads placed on floating platforms above the water surface to avoid water splashing on the filter surface. Specifics on the floating platforms (height above water, how they were anchored in place) were not provided.

The first trial was conducted on June 16, 1998. Pre-application samples were collected simultaneously from the Atlantic and Bay sites at 17:00 to 18:40 hours. Permethrin was applied by ground ULV starting at 20:00, with filter samples collected from 22:00 to 01:00. The second trial was conducted on July 28, 1998. Pre-application samples were collected simultaneously from the Atlantic and Bay sites at 15:00 to 17:00 hours. Permethrin was applied by ground ULV starting at 20:00, with filter samples collected from 22:00 to 0:45 on both sides concurrently. The third trial was conducted on September 22, 1998. Pre-application samples were collected simultaneously from the Atlantic and Bay sites at 16:20 to 17:30 hours. Permethrin was applied by ground ULV starting at 20:00. Filter samples were collected, but specifics on the time of collection were not provided in the report.

Samples were collected just prior to each application and 2-4 hours after the application. After samples were collected, dichloromethane was added to initiate extraction and reduce degradation. Samples were brought back to the Mote Marine Laboratory for further processing and analysis. Gas chromatography-mass spectrometry (GC-MS) analyses were conducted using a Varian Systems Saturn II ion trap mass spectrometer coupled with a Varian 3400 gas chromatograph. GC separations were performed on a DB-5 column. Field blanks, spiked standard recoveries, and surrogate recovery standards were used for quality control. The detection limit for permethrin on the filters was 0.2 $\mu g/m^2$.

Figure 8. Layout of Deposition Samplers in Florida Bay and Atlantic Ocean



Summary of Reported Results:

An analysis of the drop size distribution of the three trial sprays was not conducted. The application rate for permethrin was 5.5 fluid ounces per acre. Truck speed and a description of the equipment used in the ground spray were not provided, but the applications occurred between mile markers 89 and 91, indicating a travel distance of approximately 2 miles. A review of the label indicates that an application rate of 6 fluid ounces per minute, applied by a vehicle traveling 5 mph, would equate to an application rate of 0.0045 lbs permethrin per acre.

For the first trial, permethrin concentrations on filter pads collected in the Florida Bay (downwind of application) 3-6 hours after application ranged from 4.6 to 15.8 µg/m^2 (0.46 to 1.58 ng/cm^2). The wind was out of the east-southeast at 5 knots (5.75 mph). Permethrin was not detected on the filters collected on the Atlantic side (upwind direction). For the second trial, permethrin concentrations on filter pads collected in the Florida Bay (downwind of application) 3-6 hours after application ranged from 1.1 to 17.1 µg/m^2 (0.11 to 1.71 ng/cm^2). The wind was out of the east-southeast at 12 knots (13.8 mph). Permethrin was not detected on the filters collected on the Atlantic side (upwind direction). For the third trial, permethrin concentrations on filter pads collected in the Atlantic (downwind of application) 3-6 hours after application ranged from 13.6 to 51.0 µg/m^2 (1.36 to 5.10 ng/cm^2). The wind was out of the north at 5-10 knots (5.75–11.5 mph). Permethrin was not detected on the filters collected on the Florida Bay side (upwind direction).

Average recovery of permethrin from filters ranged from 99 to 110%.

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8. Preftakes, C.J., Schleier, J.J. III, Peterson, R.K.D. 2011. *Bystander exposure to ultra-low volume insecticide applications used for adult mosquito management.* International Journal of Environmental Research and Public Health, 8:2142-2152

Reviewer Conclusions:

This study provides supplemental information on pesticide deposition following ground ultra-low volume (ULV) applications. The VMD of the droplets was less than 30 microns, comparable to requirements for etofenprox ground ULV applications. Indirect measurements of fluorescent tracers were used to estimate deposition of permethrin, instead of actual analytical measurements. A summary of deposition results was provided, instead of individual replicate data.

Study Methods:

In 2009 and 2010, field trials were conducted in southwest Montana to assess dermal exposure from ground ULV applications of two formulations of permethrin: Permanone 30-30, an oil-based formulation with 30% permethrin, and Aqua-Reslin, a water-based formulation with 20% permethrin. Fluorescent tracers were added to the formulations to quantify the amount of deposition. Tinopal OB, an oil-based tracer, was added to the Permanone application at a concentration of 12 g/L, and Fluorescein, a water-based tracer, was added to the Aqua-Reslin at a

concentration of 14 g/L. Permanone 30-30 was mixed 1:2:1 with Crystal Plus 70T light mineral oil and ACS grade toluene and was applied at a flow rate of 192 mL/min. Aqau-Reslin was mixed 1:1 with deionized water and applied at a flow rate of 192 mL/min. Both products were applied at a rate of 7.85 g/ha (0.007 lbs/A) of permethrin.

A total of ten applications of Permanone 30-30 and ten applications of Aqua-Reslin were made over two years, between July 7, 2009 and August 5, 2009, and between August 2, 2010 and August 12, 2010. No more than 3 applications were made for any given formulation in any given night, and applications began no earlier than 18:00 h Mountain Standard Time. Applications were made via a truck-mounted Guardian 95 ES ULV cold-fogger. The truck was driven at 16.1 km/hr (10 mph), perpendicular to the wind direction. The sprayer nozzle was oriented 135º with respect to the ground. The average wind speed, temperature, and relative humidity for all of the applications were 213 cm/s, 19ºC, and 48%, respectively. A DC-III portable droplet measurement system was used to measure the VMDs, which were 21 and 19 microns for the Permanone 30-30 and Aqua-Reslin formulations, respectively.

To measure deposition, two mannequins were placed 25 and 50 meters away from the spray source. Mannequins measured 160-cm tall and 45.72 cm from shoulder to shoulder. Tyvek disposable suits were placed over the mannequins and were used as backing for the deposition patches. Square aluminum foil patches, measuring 121 cm^2, were used as deposition samplers and placed on each arm and leg, the upper chest, and the groin of each mannequin. An additional patch was placed on the center of the back opposite the direction of the spray. A second piece of aluminum foil was placed behind each sampler to prevent contact between the sampler and the suit and possible deposition of pesticide on the suit.

Sample patches were removed with tweezers and placed in 60 mL I-Chem jars with Teflon lids. Tweezers were rinsed with a 1:1 solution of acetone:toluene between each sample to prevent cross-contamination. Two control samples (121 cm^2 aluminum squares) were attached to cardboard via binder clips to two mannequins located at the control site upwind of the application. Control samples were collected following the same procedures as the sample patches.

Tinopal and fluorescein were extracted using 15 mL of toluene and deionized water, respectively. Each jar was shaken for 10 seconds and the liquid decanted into a 20 mL analysis vial. Vials were wiped with KimWipes prior to analysis. A GFL-1A fluorometer was used to detect the amount of light absorbed at a specific wavelength, representing the amount of tracer present in the sample. For fluorescein, the emission filter was 465 nm and the detection filter was 530 nm. For tinopal, the emission filter was 370 nm and the detection filter was 430 nm. The detection limits for tinopal and fluorescein were 0.12 and 0.15 ng/cm^2, respectively. Based on this information, the detection limits for permethrin in Permanone 30-30 and Aqua-Reslin were 0.76 and 0.2 ng/cm^2, respectively.

<u>Summary of Reported Results</u>:

Study authors reported that there were no significant differences in deposition measurements between the sampling years ($F=0.12$, $p=0.73$), the distance from the spray source ($F=1.64$,

p=0.21), front or back of the mannequins (F=3.08, p=0.081), or the placement of patches on the body (F=0.28, p=0.59). However, study authors indicated dermal deposition of Permanone 30:30 was significantly less than Aqua-Reslin (F=6.2, p=0.013). **Figure 9** depicts the deposition measurements by body part. Study authors posit that greater permethrin was deposited for the Aqua-Reslin formulation due to the higher density of the formulation, causing its droplets to settle out of the air faster. Average permethrin depositions on the mannequin bodies were 4.2 and 2.1 ng/cm^2 for Aqua-Reslin and Permanone 30-30, respectively. Given an application rate of 0.007 lbs a.i./A, this equates to an average deposition rate of 5.4 and 2.7%. It should be noted that, based on the standard error for the arms for the Aqua-Reslin applications (**Figure 9**), a deposition of approximately 8 ng/cm^2 was observed, equating to a deposition rate as high as 10% of the applied. Information on deposition levels found in control samples was not provided.

Figure 9. Average deposition (±SE) of permethrin on bystander mannequins 25 and 50 meters from the spray source.